THE COMPLETE LARVAL DEVELOPMENT OF *Palaemon paivai* FAUSTO FILHO, 1967 (DECAPODA, PALAEMONIDAE) REARED IN THE LABORATORY

Fernando A. Abrunhosa[1]
Francisco de Assis Pereira da Costa [2]
Manoel Gomes Moura[3]
Marcus Alexandre Borges Pires[4]

ABSTRACT

The complete larval development of *Palaemon paivai* is described from larvae reared in the laboratory. Ovigerous females were collected during low tide from small ponds at Meireles beach, Fortaleza City, Brazil. After hatching, larvae were placed into 500ml Erlenmeyer's with constant aeration. The larvae were fed with *Artemia* nauplii. Microalgae *Nannochloropsis* sp. was added to the culture. Samples of each larval stage were preserved in ethylic alcohol 70% + glicerine (1:1). The larvae passed through 8 zoeal stages before reaching the juvenile I stage in a period of 28 days. Morphological comparisons with previously reported descriptions on *Palaemon* genus in Brazil are briefly discussed in the present study
Key words - larval culture, morphological description, neotropical species.

RESUMO

O desenvolvimento larval completo de *Palaemon paivai* Fausto-Filho, 1967 (Decapoda, Palaemonidae) cultivado em laboratório

O desenvolvimento larval completo de *Palaemon paivai* é descrito a partir de larvas cultivadas em laboratório. Fêmeas ovígeras foram coletadas durante baixa-mar em pequenas lagoas na praia do Meireles (Fortaleza, Brasil). Depois da eclosão, as larvas foram transferidas para Erlenmeyers de 500ml, com aeração constante. As larvas foram alimentadas com náuplios de *Artemia*. A microalga *Nannochloropsis* sp. foi adicionada ao cultivo. Amostras de cada estágio foram preservadas em álcool 70%+glicerina (1:1). As larvas passaram por 8 estágios de zoea antes de alcançar o primeiro estágio juvenil, em um período de 28 dias. Comparações morfológicas com descrições anteriores sobre o gênero de *Palaemon* que ocorrem no Brasil são brevemente discutidas no presente estudo.
Palavras-chave - cultivo larval, descrição morfológica, espécie neotropical.

[1] Professor da Faculdade de Biologia, UFPa, Campus de Bragança, Laboratório de Carcinologia, CEP. 68.6000-000-Bragança-PA. E-mail: faraujo@ufpa.br
[2] Pesquisador do Laboratório de Ciências do Mar, UFC.
[3] Engenheiro de Pesca da Prefeitura Municipal de Fortaleza, PMF.
[4]. Mestre pela Faculdade de Biologia, UFPa, Campus de Bragança

INTRODUCTION

Four species of the genus *Palaemon* Weber, 1795 have been found in Brazilian coast: *P. northropi* (Rankin, 1898), *P. pandaliformis* (Stimpson, 1871), *P. ritteri* Holmes, 1895 and *P. paivai* Fauto Filho, 1967 (RAMOS-PORTO; COELHO, 1998). The latter is a small marine prawn commonly found in routine collections accomplished at Meireles beach, Fortaleza City, Northeastern Brazil (FAUSTO-FILHO, 1967). They are found with other species such as *P. northropi*, living in costal ponds formed by rocks or reefs during low tides in which, they present close morphological similarities. Thus, investigations on larval descriptions may be useful in the classification of the *palaemonid* species that occur in marine or brackish waters of Brazil.

Within this genus in Brazil, the larval morphology has been described for *P. northropi* (COELHO; SOARES; BARRETO, 1981 and MOURA; ABRUNHOSA; PEREIRA DA COSTA, 1990) and for *P. pandaliformis* (GAMBA, 1998). The developmental morphology of larvae for *P. ritteri* is still unknown.

The present study provides a detailed description and illustrations of zoeal and juvenile stages of *P. paivai* from larvae reared in the laboratory. A brief comparative discussion of other species of the genus *Palaemon* from Brazil is also given.

MATERIAL AND METHODS

Three ovigerous females of *P. paivai* were collected during low tide from small ponds at Meireles beach, Fortaleza City, northeastern Brazil. They were caught with dip nets and placed in a 15ml container filled with seawater. Until hatching, the females were kept individually, in the Laboratory of Marine Science (Labomar), in filtered (5mm) seawater (salinity 35) recipients (capacity: 15ml) with constant aeration and they were fed with *Artemia* nauplii.

After hatching, groups of 60, 56 and 20 larvae (each group was originated from the spawning of the three females) were transferred to 3 aquariums (15ml). These were equipped with a biological filter and constant aeration.

Approximately 20 days after hatching, the larvae were placed into 3 Erlenmeyer's (500ml) where they were kept until molting to juvenile I. Every day, the larvae were transferred into new filtered seawater flask. Average temperature was 26.4°C (±6) ranging from 24.1 to 30.3°C and salinity 35.7 (±3) ranging from 35 to 38. Microalgae *Nannochloropsis* sp., at the concentration about 1.500.000 cells./ml, was added every day to the culture recipients to maintain the water quality.

Larvae and exuviae of each larval stage were preserved in alcohol 70% and posteriorly, immersed in alcohol 70% + glycerol (1:1) solution. They were dissected using fine needles under an ocular microscope. The carapace length was measured (aided by an ocular micrometer disc) from rostral tip to the posterior margin of the telson.

The first zoeal stage of *P. paivai* was fully described. Only the main differences from the first zoea are described, following Moura, Abrunhosa and Pereira da Costa (1990), Gamba (1998), Knowlton and Vargo (2004) and Shy, Chang and Lai (2005).

RESULTS

The larvae pass through 8 zoeal stages before molting to juvenile I. Total larval period, from zoea I to the metamorphosis into first juvenile, averaged 28 days.

ZOEA I

Total length: 2.70-2.90 mm.

Carapace (Figure 1ℓ): Eyes sessile; rostrum slightly curved upward, lacking spines; carapace with anterior margin bearing a well-developed pterigostomial spine.

Antennule (Figure 1a): Unsegmented, with 2 flagella, inner flagellum as a long plumose seta; outer flagellum with 4 aesthetascs and 1 plumose seta.

Antenna (Figure1b): Peduncle unsegmented; exopod segmented distally with 2 + 4 + 5 plumose setae; endopod with a long plumose seta.

Maxillule (Figure 1c): Endopod unsegmented with 1 terminal seta; basal endite with 5 setae; coxal endite with 4 distal and 1 short lateral setae, respectively.

Maxilla (Figure1d): Scaphognathite with 4 + 1 plumose setae; endopod with 1 + 2 plumose setae distal and proximal lobes of the basal endite with 4 + 3 plumose setae; distal and proximal lobes of coxal endite fused with 3 + 1 plumose setae.

Maxilliped 1 (Figure1e): Basis with 6 simple setae; endopod short with 5 setae (4 on apex); exopod longer than endopod with 2 + 4 plumose setae.

Maxilliped 2 (Figure1f): Basis with 3 simple setae; endopod 3-segmented, the distal with 1 long and curved spine and 3 + 1 setae, median segment with 2 setae distally; exopod with 4 + 4 plumose setae.

Maxilliped 3 (Figure1g): Basis with 2-3 setae; endopod 4-segmented, similar to previous; exopod with 4 + 4 plumose setae.

Pereiopods 1 and 2 (Figure1h, 1i): Rudimentary, segmented and biramous.

Abdomen (Figure1l): 6-segmented, 5th segment with a small lateral spine; 6th segment fused with telson; pleopods absent.

Telson (Figure 1j): Fan-shaped, posterior margin

almost straight with rounded edges bearing 14 (7 + 7) plumose seta.

ZOEA II

Total length: 3.00 - 3.30 mm.
Carapace (Figure 2ℓ, 2m): Eyes stalked; carapace with 1 spine on the superior margin behind the eyes and directed forward; supra-orbital spine well-developed; pterigostomial spine short.

Antennule (Figure 2a): Peduncle 2-segmented; distal segment with 1 flagellum, 1 long seta and 6 small simple setae; outer flagellum with 4 aesthetascs and 1 simple seta; distal margin of proximal segment with 1 long plumose seta on inner margin and rounded by simple setae, sub-distal region of proximal segment with 4-5 setae in arc-shaped line along outer edge and 1 median setae in the inner margin; stylocerite

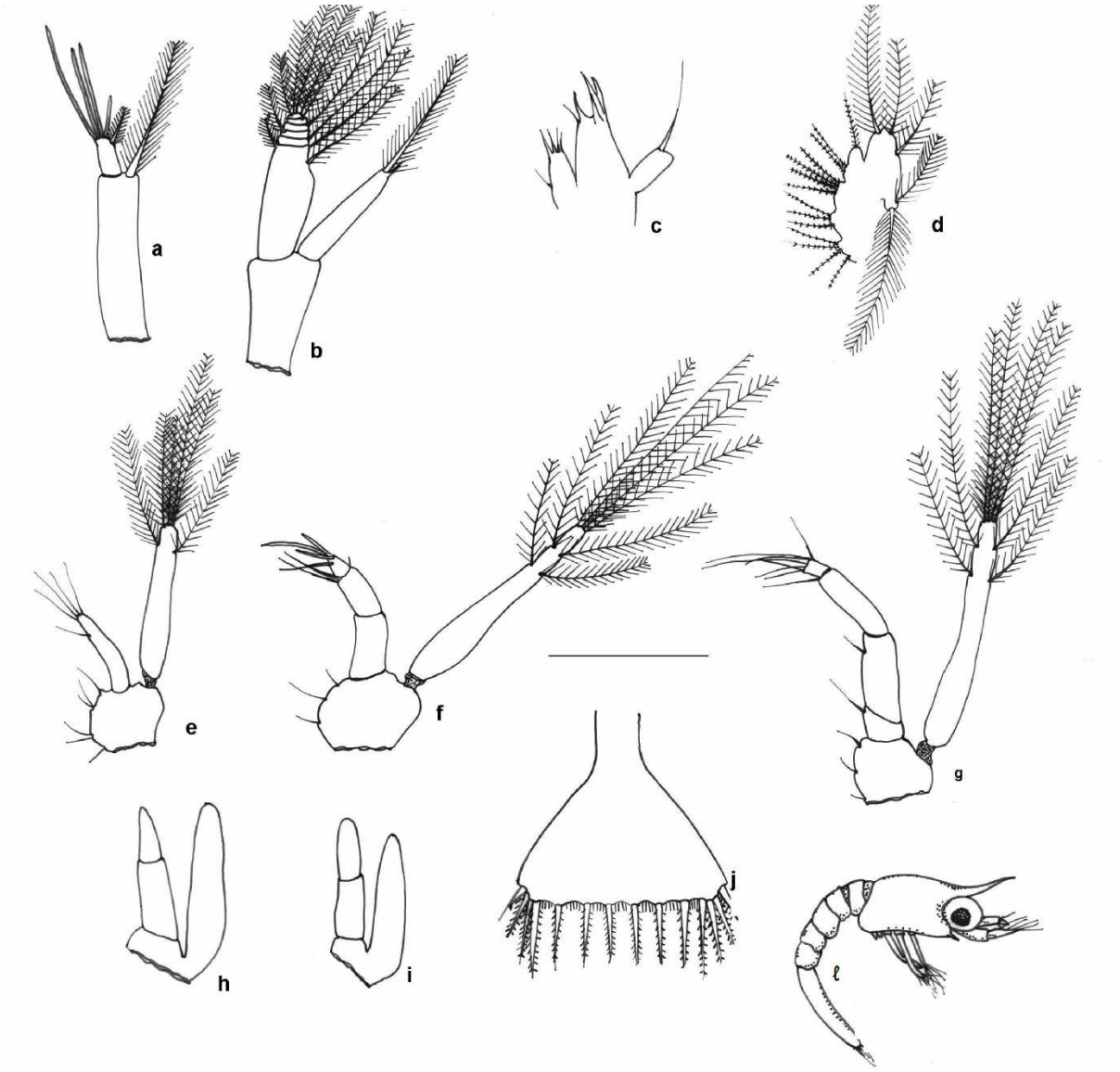

Figure 1. *Palaemon paivai* FaustoFilho, 1967. Zoea I. (a) antennule; (b) antenna; (c) maxillule; (d) maxilla; (e) first maxilliped; (f) second maxilliped; (g) third maxilliped; (h) first pereiopod; (i) second pereiopod; (j) telson; (ℓ) zoea I, lateral right view. Scale bar: a-b and d-i = 0.3 mm; c = 0.15 mm; j = 0.45 mm; ℓ = 2.9 mm.

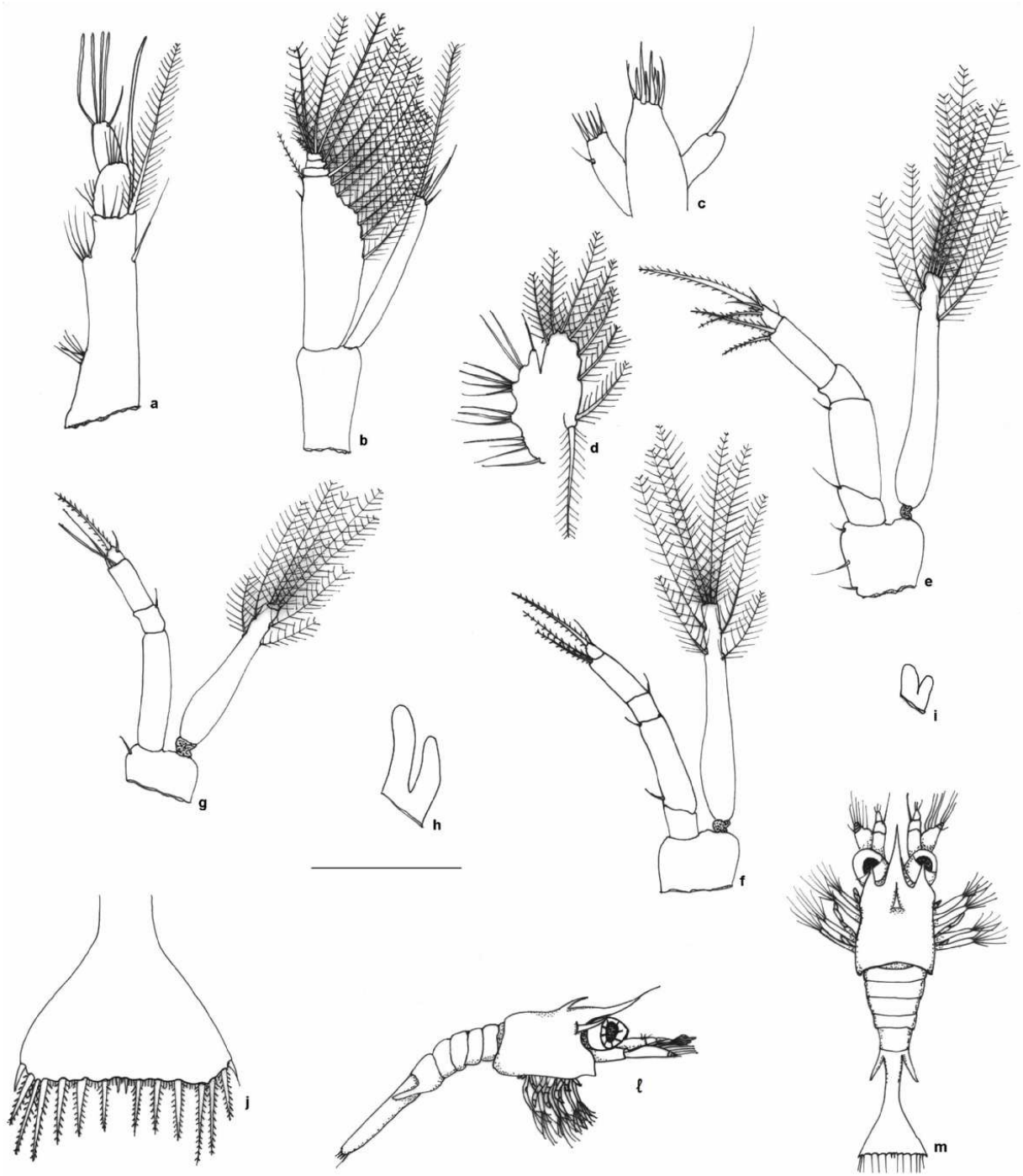

Figure 2. *Palaemon paivai* FaustoFilho, 1967. Zoea II. (a) antennule; (b) antenna; (c) maxillule; (d) maxilla; (e) third maxilliped; (f) first pereiopod; (g) second pereiopod; (h) third pereiopod; (i) fourth pereiopod; (j) telson; (l) zoea II, lateral right view; (m) zoea II, dorsal view. Scale bar: a-b and d-f = 0.3 mm; c = 0.15 mm; j = 0.45 mm; l-m = 3.3 mm.

little-prominent with about 6 setae.
Antenna (Figure 2b): Exopod with 16 plumose and 1 simple setae; endopod 1 long and 4 simple setae on the apex.
Maxillule (Figure 2c): Basal endite with 7 setae; coxal endite with 5 distal and 1 short laterally setae.
Maxilla (Figure 2d): Scaphognathite with 7 + 1 plumose setae.
Pereiopod 3 (Figure 2h): Present, rudimentary and biramous.
Abdomen (Figure 2ℓ, 2m): 5th segment with a pair of curved spine surpassing median portion of the 6th segment.
Telson (Figure 2j): Similar to previous stage except for addition of 2 small non-plumose median spines.

ZOEA III

Total length: 3.15 - 3.90mm.
Carapace (Figure 3m, 3n): Carapace with 2 spines on the superior margin behind the eyes and directed forward; pterigostomial spine bifurcated.
Antenna (Figure 3a): Exopod with 16-18 plumose and 2 simple setae; endopod 3-segmented, distal segment with 3 + 2 + 2 setae on apex.
Maxilla (Figure 3c): Scaphognathite with (11-12) + 2 plumose setae.
Maxilliped 3 (Figure 3e): Endopod 5-segmented, longer than exopod.
Pereiopod 5 (Figure 3h, 3i, 3j): Rudimentary, unireme.
Abdomen (Figure 3m, 3n): Spines on 5th segment more curved and more developed compared to the previous stage.
Telson (Figure 3l, 3m): Articulated with 6th segment; margin posterior with 1 pair of spine on the median portion and 6 pairs of plumose spines; endopod little-developed lacking setae; exopod with 10-11 plumose setae.

ZOEA IV

Total length: 4.20 - 4.80 mm.
Carapace (Figure 4l, 4j): Carapace with 3 spines on the superior margin, 2 behind the eyes, and directed forward.
Antennule (Figure 4a): Distal margin with inner flagellum with a small protuberance bearing a long plumose seta; proximal segment with distal margin bearing 1 long plumose seta on inner margin and 6 simple setae on the outer margin, sub-distal region of proximal segment with 8 setae in arc-shaped line along outer edge and 3 median setae in the inner margin; stylocerite more prominent.
Antenna (Figure 4b): Endopod more developed surpassing median portion of exopod; exopod with 21 + 1 plumose setae.
Maxilla (Figure 4c): Scaphognathite with (18-23) + (1-3) plumose setae.
Maxilliped 1 (Figure 4e): Endopod 2-segmented, distal segment with 4 plumose setae on apex; basis with 7 setae; coxa with 1 inner seta; epipod bilobed.
Pereiopod 3 (Figure 4g): Endopod 5-segmented, longer than exopod; exopod with 4 plumose setae.
Pereiopod 4 (Figure 4h): Rudimentary and uniramous, a little more developed compared to the previous stage.
Abdomen (Figure 4ℓ, 4j): Spines of the 5th segment surpassing median region of the 6th segment.
Telson (Figure 4i, 4ℓ): Narrower compared to the previous stage with 4 pairs of marginal setae; exopod with 16-19 plumose setae and about 6 setae on the dorsal margin; endopod with 8-10 plumose marginal setae and 7 setae on the dorsal margin.

ZOEA V

Total length: 5.40 mm.
Carapace (Figure 5r): Carapace with 2 small setae on the base of the 1st spine.
Antennule (Figure 5a): Outer flagellum with additional setae on the median portion; margin distal of distal segment with an additional seta.
Antenna (Figure 5b): Exopod with 26-29 plumose setae.
Maxilla (Figure 5d): Scaphognathite with (23-26) + 4 plumose setae.
Maxilliped 1 (Figure 5e): Caridean lobe of exopod present with 3 plumose setae; basis with 8 setae; epipodite of the coxa more developed.
*Pereiopod 4 (*Figure 5i): Endopod longer than exopod, ending in a strong spine on the apex and 1 small simple seta; exopod with 4 + 2 plumose setae.
*Pereiopod 5 (*Figure 5j): Well-developed, 5-segmented, uniramous with 1 strong spine terminal.
Pleopods 1-5 (Figure 5ℓ-p): Rudimentary and bilobed (except 1st pleopod).
Telson (Figure 5q): Rectangular in shape; posterior margin with 4 pairs of plumose setae and a pair of central spines; exopod with 20-23 plumose setae; endopod with 13-16 plumose marginal setae and 8 on the dorsal margin.

ZOEA VI

Total length: 5.75 – 6.60 mm.
Carapace (Figure 9a, b): Similar to previous stage with rostral spine more elongated.
Antennule (Figure 6a): Outer flagellum with 1 + 4 + 3 + 1 aesthetascs on inner margin; 5 long plumose setae rounded anterior margin of the distal segment; increasing in setae number on the distal and median segments; stylocerite with approximately 8 plumose setae on outer side and 6 plumose setae in the base.
Antenna (Figure 6b): Endopod slightly longer than

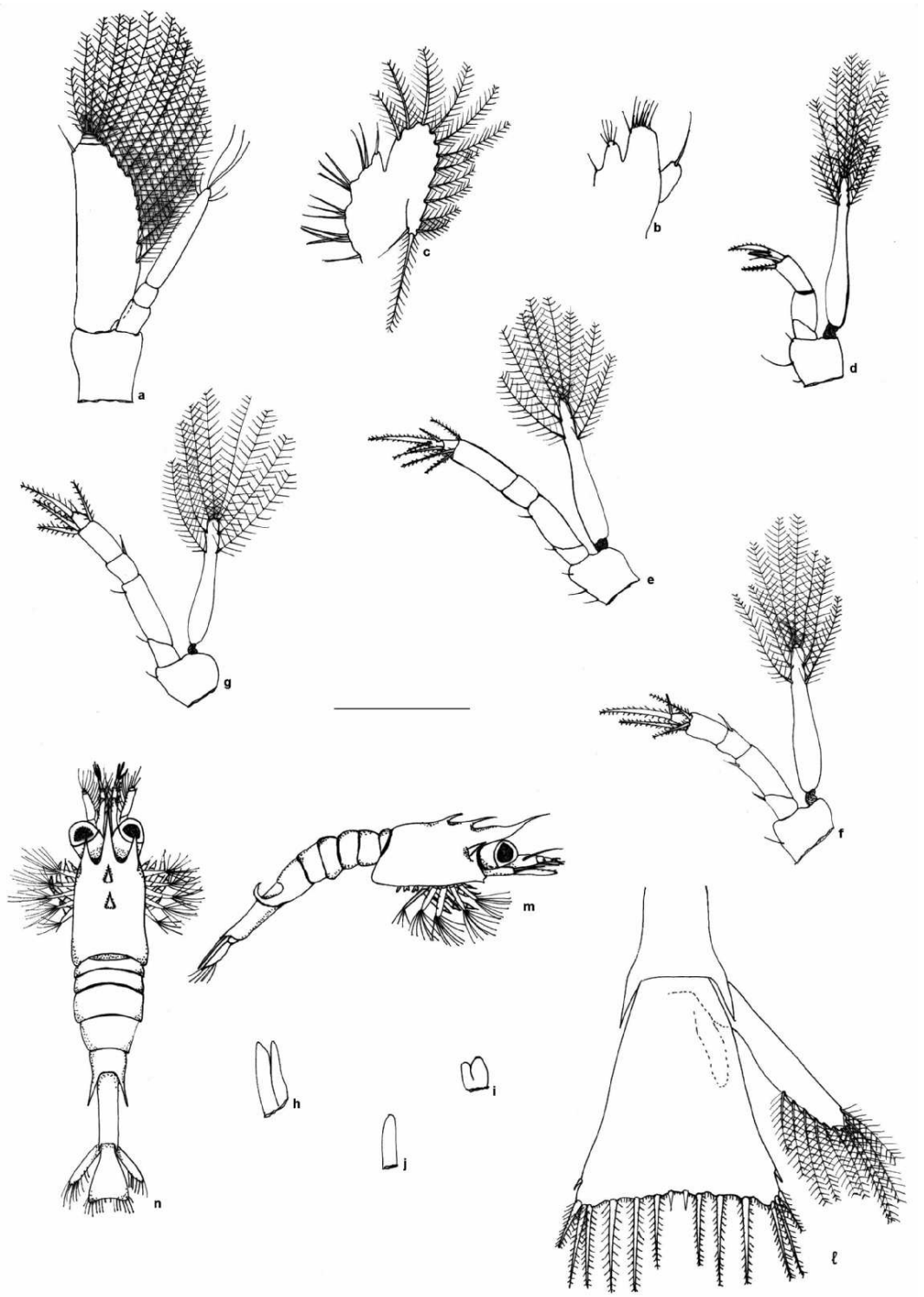

Figure 3. *Palaemon paivai* Fausto-Filho, 1967. Zoea III. (a) antenna; (b) maxillule; (c) maxilla; (d) second maxilliped; (e) third maxilliped; (f) first pereiopod; (g) second pereiopod; (h) third pereiopod; (i) fourth pereiopod; (j) fifth pereiopod; (ℓ) telson; (m) zoea III, lateral right view; (n) zoea III, dorsal view. Scale bar: a-c and ℓ = 0.3 mm; d-j = 0.45 mm; m-n = 3.9 mm.

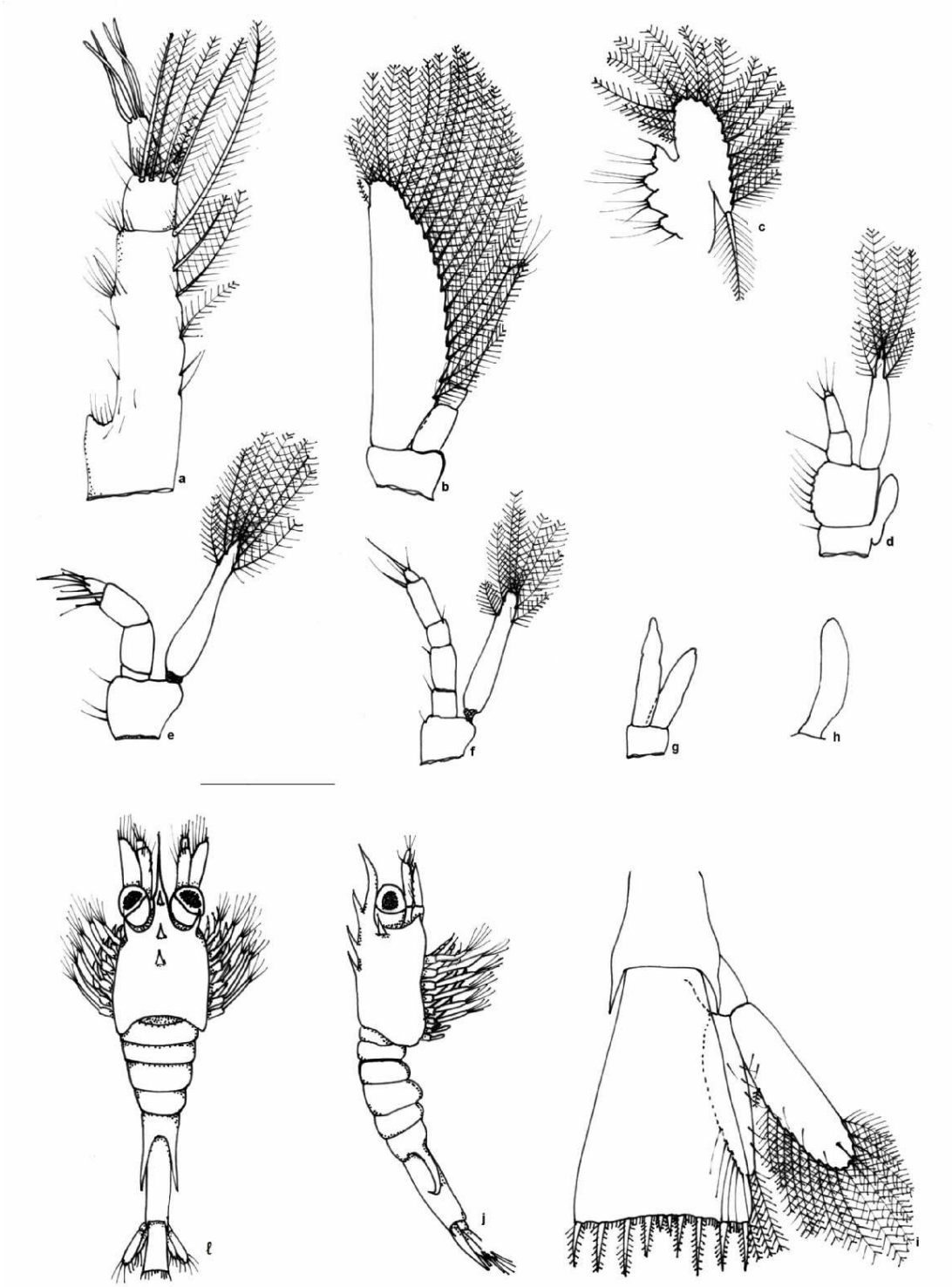

Figure 4 - *Palaemon paivai* Fausto-Filho, 1967. Zoea IV. (a) antennule; (b) antenna; (c) maxilla; (d) first maxilliped; (e) second maxilliped; f) third pereiopod; (g) fourth pereiopod; (h) fifth pereiopod; (i) telson; (j) zoea IV, lateral right view; (ℓ) zoea IV, dorsal view. Scale bar: a-c and g-i = 0.3 mm; d-f = 0.45 mm; j and ℓ = 4.2 mm.

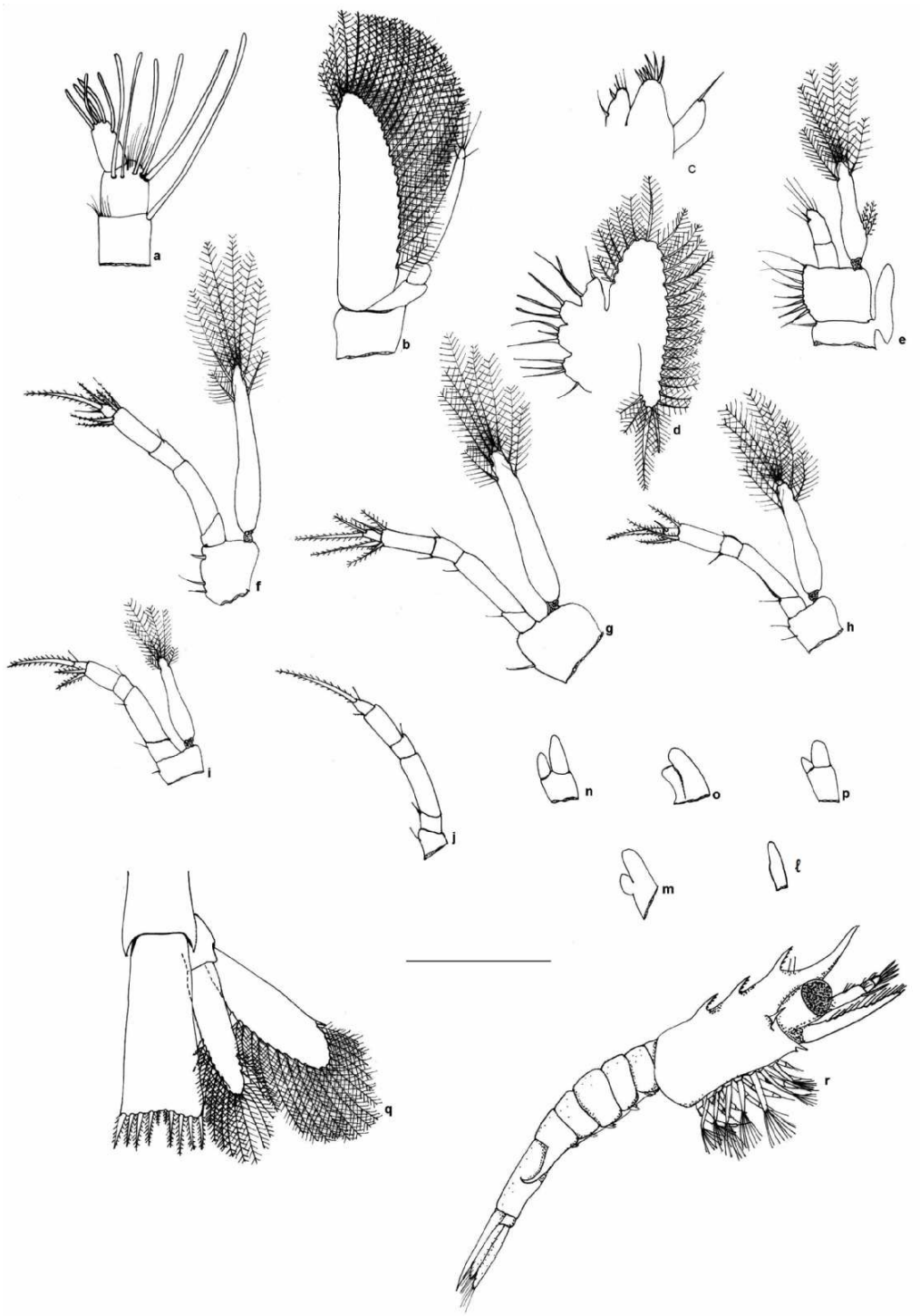

Figure 5 **-** *Palaemon paivai* Fausto-Filho, 1967. Zoea V. (a) antennule; (b) antenna; (c) maxillule; (d) maxilla; (e) first maxilliped; (f) third maxilliped; (g) first pereiopod; (h) third pereiopod; (i) fourth pereiopod; (j) fifth pereiopod; (ℓ-p) pleopods; (q) telson; (r) zoea V, lateral right view. Scale bar: a and c-d = 0.3 mm; b and e-q = 0.45 mm; r = 5.4 mm.

exopod with 6 segmentations; exopod with 33-39 plumose setae.
Maxillule (Figure 6c): Basal endite with 9 setae; coxal endite with 4 + 3 setae.
Maxilla (Figure 6d): Scaphognathite with 35 + 6 marginal plumose setae.
Maxilliped 1 (Figure 6e): Caridean lobe with 8 plumose setae; exopod with 4 pairs of plumose setae; basis with 14 setae.
Maxilliped 2 (Figure 6f): Endopod 5-segmented; exopod with 6 + 6 plumose setae.
Maxilliped 3 (Figure 6g): Exopod with 6 + 6 plumose setae.
Pereiopod 1, 2 and 3 (Figure 6h, 6i and 6j): Exopod with 6 + 6 plumose setae.
Pereiopod 4 (Figure 6j): Exopod with 5 + 5 plumose setae.
Pereiopod 5 (Figure 6l): Similar to previous stage but a little more developed.
*Pleopods 1 and 5 (*Figure 6m, 6n): Still rudimentary a little more developed; 5th pleopod showing plumose setae.
*Telson (*Figure 6o): narrower than previous stage; exopod with 30 marginal plumose setae; endopod with 27-30 plumose setae.

ZOEA VII

Total length: 7.80 – 8.70 mm.
Antennule (Figure 7a): Outer flagellum with 5 simple setae on apex and 4, 4, 4 and 3 aesthetascs on inner margin; inner flagellum more developed with 4 setae on apex.
Antenna (Figure 7b): Endopod with 9 segmentations; exopod about 43 plumose setae.
Maxilla (Figure 7c): Scaphognathite with 57 marginal plumose setae; distal and proximal lobes of basal endite with 6 and 2 plumose setae, respectively; distal and proximal lobes of coxal endite with 5 and 4 setae, respectively.
Maxilliped 3 (Figure 7d): Exopod with 7 + 7 plumose setae.
Pereiopods 1 (Figure 7e): Endopod sub-chelate; exopod with 8 + 8 plumose setae.
Pereiopods 3 and 4 (Figure 7f, 7-g): Exopod with 7 + 7 plumose setae.
Pleopods 1and 5 (Figure 7i, 7j): Exopod with 12 plumose setae; endopod lacking setae.
Telson (Figure 7ℓ): Endopod elongate; exopod with 35 and 38 plumose setae, respectively.

ZOEA VIII

Total length: 10.10 mm.
Antennule (Figure 8a): Outer flagellum biramous, inner ramous with 3,3,3, 4,4,4,3,5,3 and 1 aesthetascs, respectively, outer ramous 6-7 segmented; inner flagellum with 5-7 segmentations.
Antenna (Figure 8b): Endopod with approximately 28 segmentations; exopod about 44-51 plumose setae.
*Maxillule (*Figure 8c): Basal endite with 9-11 setae; coxal endite with (8-10) + 1 + 1 setae.
Maxilla (Figure 8d): Scaphognathite with 69 marginal plumose setae; distal and proximal lobes of basal endite with11 and 9 plumose setae, respectively; distal and proximal lobes of coxal endite fused with 3 + 1 setae, respectively.
*Maxilliped 1 (*Figure 8e): Caridean lobe with 11-14 setae; basis with approximately 36 setae; coxa with approximately 4 setae and 1 epipodite bilobed on the outer margin; endopod 3-segmented with 4 setae.
*Maxilliped 2 (*Figure 8f): Endopod 5-segmented; exopod with 7 + 7 plumose setae.
*Maxilliped 3 (*Figure 8g): Endopod 5-segmented; exopod with 8 + 8 plumose setae.
Pereiopods 2 (Figure 8h): Endopod chelate; exopod with 9 + 9 plumose setae.
*Pleopods 1 and 5 (*Figure 8ℓ, 8m): Exopod with 11-14 plumose setae; endopod with 7 plumose setae (except 1st pleopod).
Abdomen (Figure 9c): 5th segment still holding a curved spine a pair of curved spine.
Telson (Figure 8n): Endopod and exopod with 41-55 plumose setae; exopod with 44-51 plumose setae.

JUVENILE I

Total length: 9.30 - 11.40 mm.
Carapace (Figure 9d): Resembling that of adult; rostrum slightly curved upward armed with 9 dorsal and 3 ventral teeth.
Antennule (Figure 10a): Outer flagellum 4-segmented, distal segment biramous on apex, outer ramous 8 - 12-segmented about 3 times inner ramous, inner ramous 2-segmented with 3,4,3,3,4,4,4 and 4 aesthetascs, respectively; inner flagellum 14-15-segmented; peduncle 3-segmented; statocyst well-developed; stylocerite about 15 setae.
Antenna (Figure 10b): Endopod about 4.6 times longer than exopod with about 53-63 segmentations exopod about 56-61 plumose setae.
Maxillule (Figure 10c): Basal endite with 17 plumose setae; coxal endite with 12 setae; endopod well-developed.
Maxilla (Figure 10d): Scaphognathite with 75 marginal plumose setae; endopod with 2 small setae; coxal endite with 1 seta; distal and proximal lobes of basal endite with 11 and 10 setae, respectively.
Maxilliped 1 (Figure 10e): Caridean lobe with about 12 setae; basis with approximately 45 setae marginal

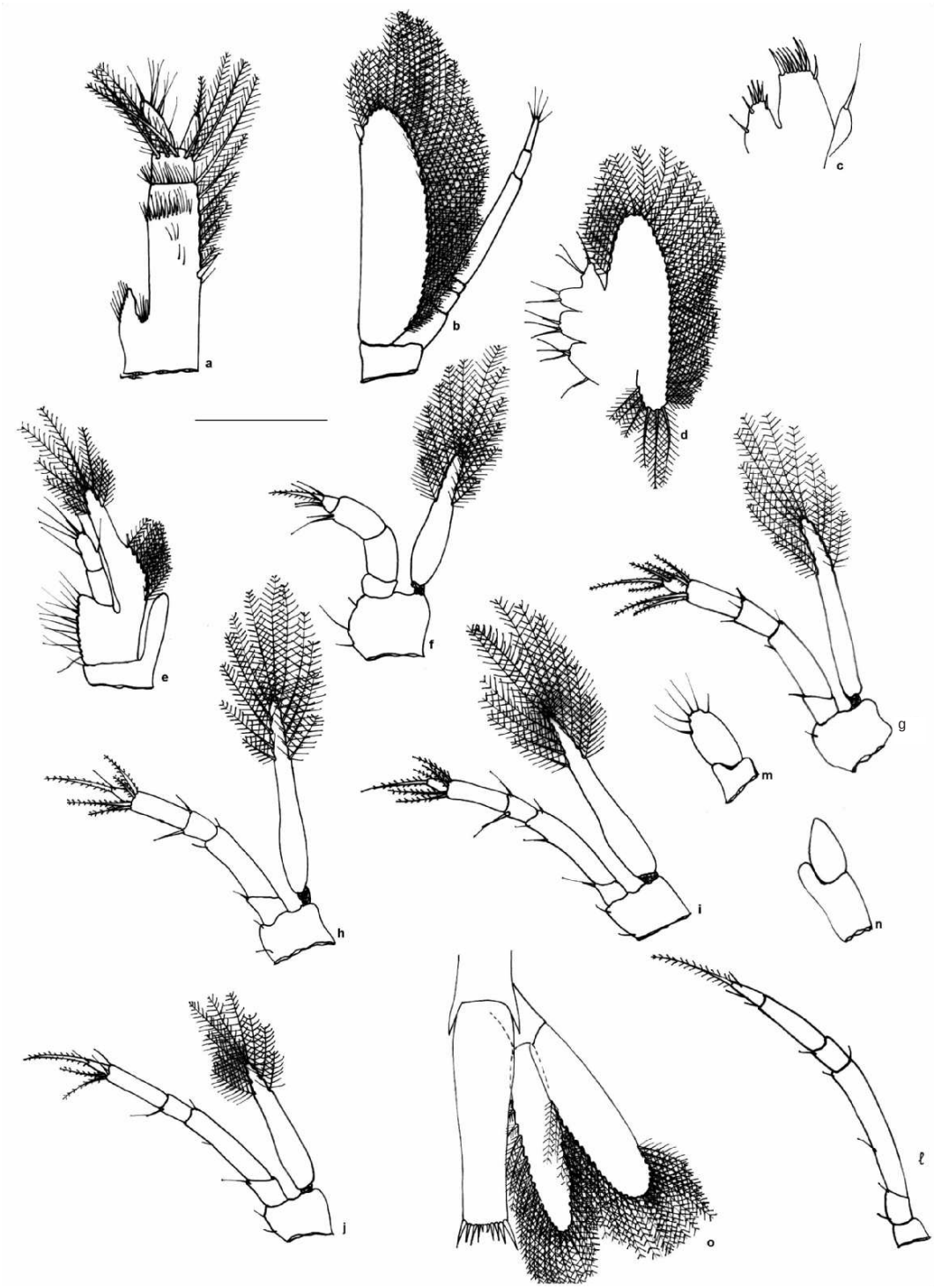

Figure 6 - Palaemon paivai Fausto-Filho, 1967. Zoea VI: (a) antennule; (b) antenna; (c) maxillule; (d) maxilla; (e) first maxilliped; (f) second maxilliped; (g) third maxilliped; (h) first pereiopod; (i) third pereiopod; (j) fourth pereiopod; (ℓ) fifth pereiopod; (m-n) pleopods; (o) telson. Scale bar: a-b and o = 0.6 mm; c-d and m-n= 0.3 mm; e-ℓ = 0.45 mm.

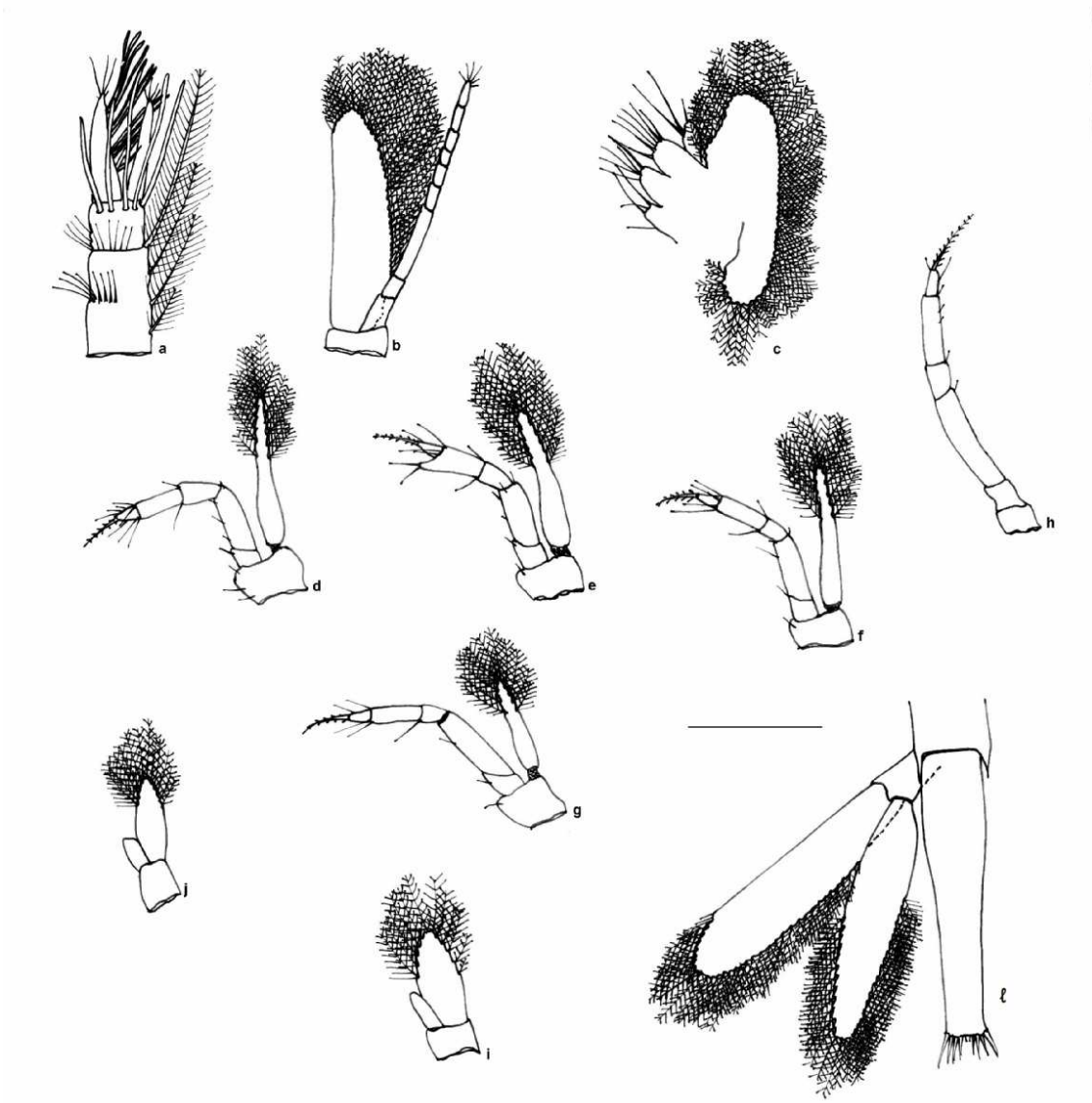

Figure 7 - *Palaemon paivai* Fausto-Filho, 1967. Zoea VII. (a) antennule; (b) antenna; (c) maxilla; (d) third maxilliped; (e) first pereiopod; (f) third pereiopod; (g) fourth pereiopod; (h) fifth pereiopod; (i-j) pleopods; (ℓ) telson. Scale bar: a = 0.6 mm; b and d-h = 0.9 mm; c =0.3 mm; i-j = 0.45 mm; ℓ = 0.7 mm

and 6 sub-marginal; coxa with 8 setae; exopod with 4 + 4 plumose setae; endopod non-segmented with 1 seta.

*Maxilliped 2 (*Figure 10f): Endopod 5-segmented; exopod smaller than endopod with 3 plumose setae.

Maxilliped 3 (Figure 10g): Endopod setose; exopod with 1 simple seta.

Pereiopods 1 and 2 (Figure10h, 10i): Chelae functional; exopods atrophied.

Pereiopods 3 and 4 (Figure 10j, 10ℓ): exopods atrophied.

Pereiopod 5 (Figure 10m): lacking exopod.

Pleopods 1 and 5 (Figure 10n, 10o): Exopod with 14 plumose setae; endopod with 8-10 plumose setae (except 1st pleopod with 6 setae).

Abdomen (Figure 9d): Fifth abdominal somite lacking the elongated spines before present in all zoeal stages.

Telson (Figure 10p): With 2 + 2 spines dorsal spines, located about ½ and ¾ the distance of the base; endopod and exopod about 59-61 plumose setae; exopod about 56-61 plumose setae.

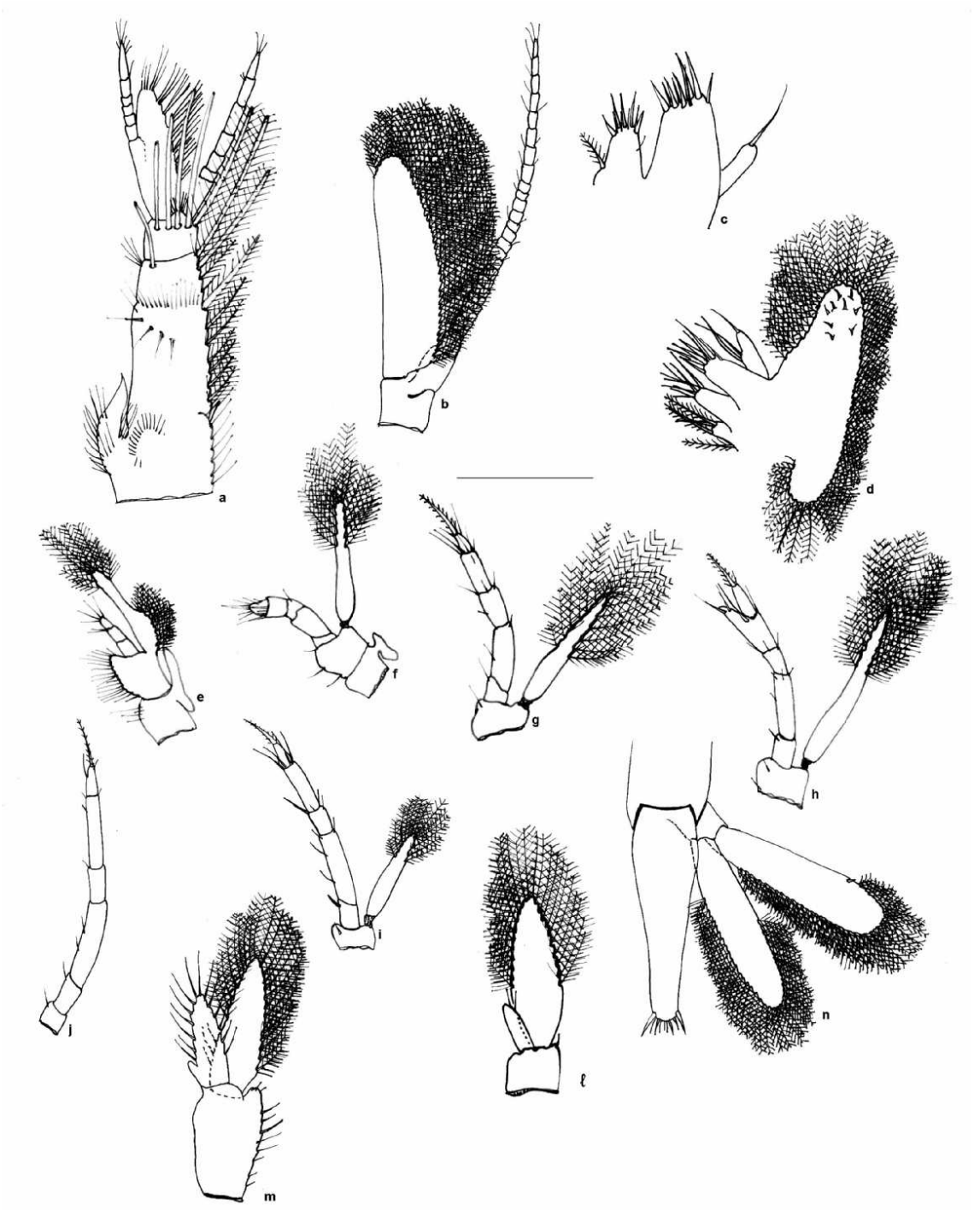

Figure 8- *Palaemon paivai* Fausto-Filho, 1967. Zoea VIII. (a) antennule; (b) antenna; (c) maxillule; (d) maxilla; (e) first maxilliped; (f) second maxilliped; (g) third maxilliped; (h) second pereiopod; (i) fourth pereiopod; (j) fifth pereiopod; (ℓ-m) pleopods; (n) telson. Scale bar: a = 0.6 mm; b, d, e-j and n = 0.9 mm; c = 0.3 mm; ℓ-m= 0.45 mm.

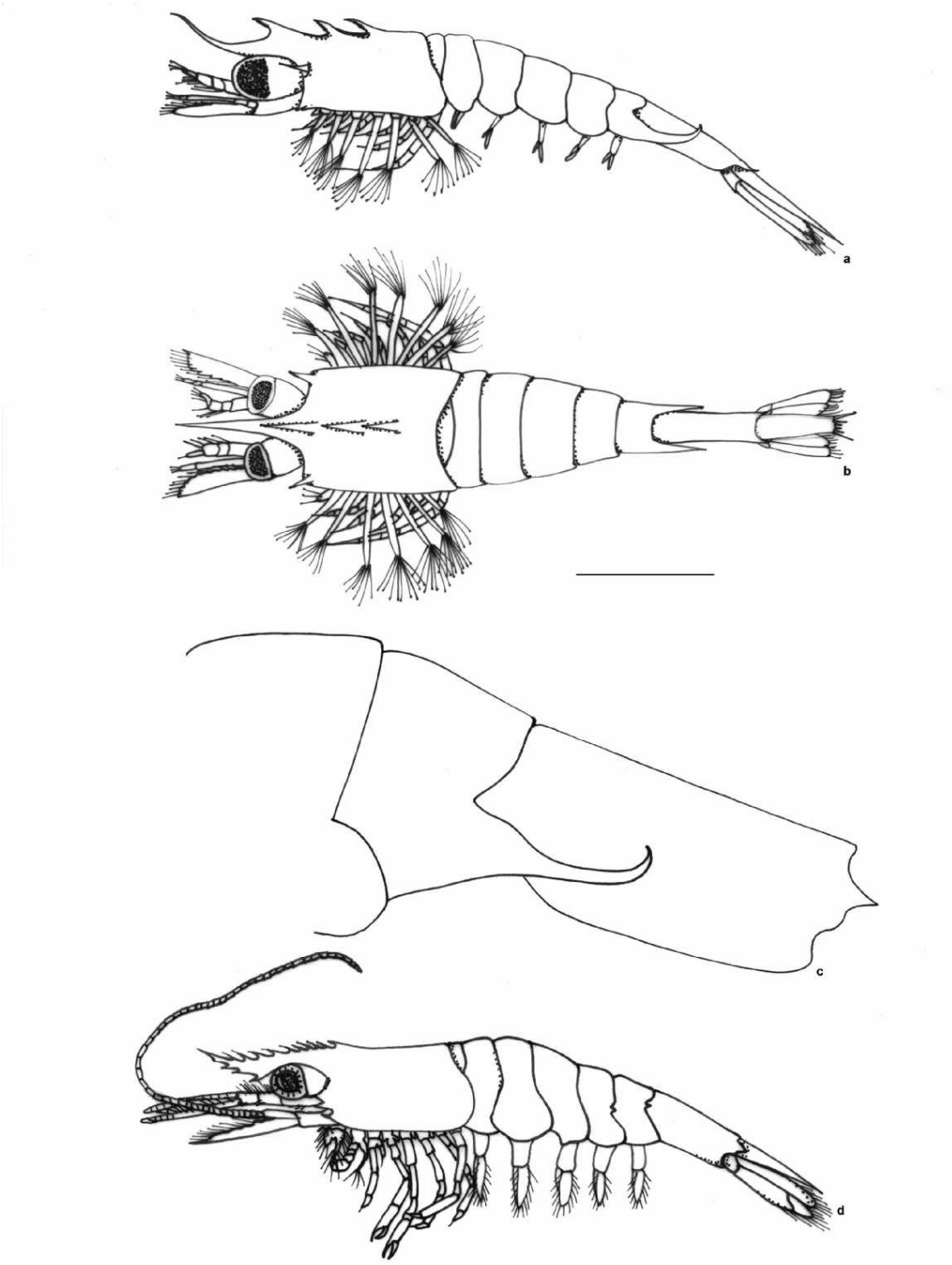

Figure 9 - *Palaemon paivai* Fausto-Filho, 1967. Zoea VI, zoea VIII and juvenile I. (a) zoea VI (lateral right view). (b) zoea VI, dorsal view; (c) 5th segment of zoea VIII, detail in lateral view; (e) juvenile I, lateral right view. Scale bar: a-b = 7.2 mm; c = 0.5 mm; d = 9.3 mm;

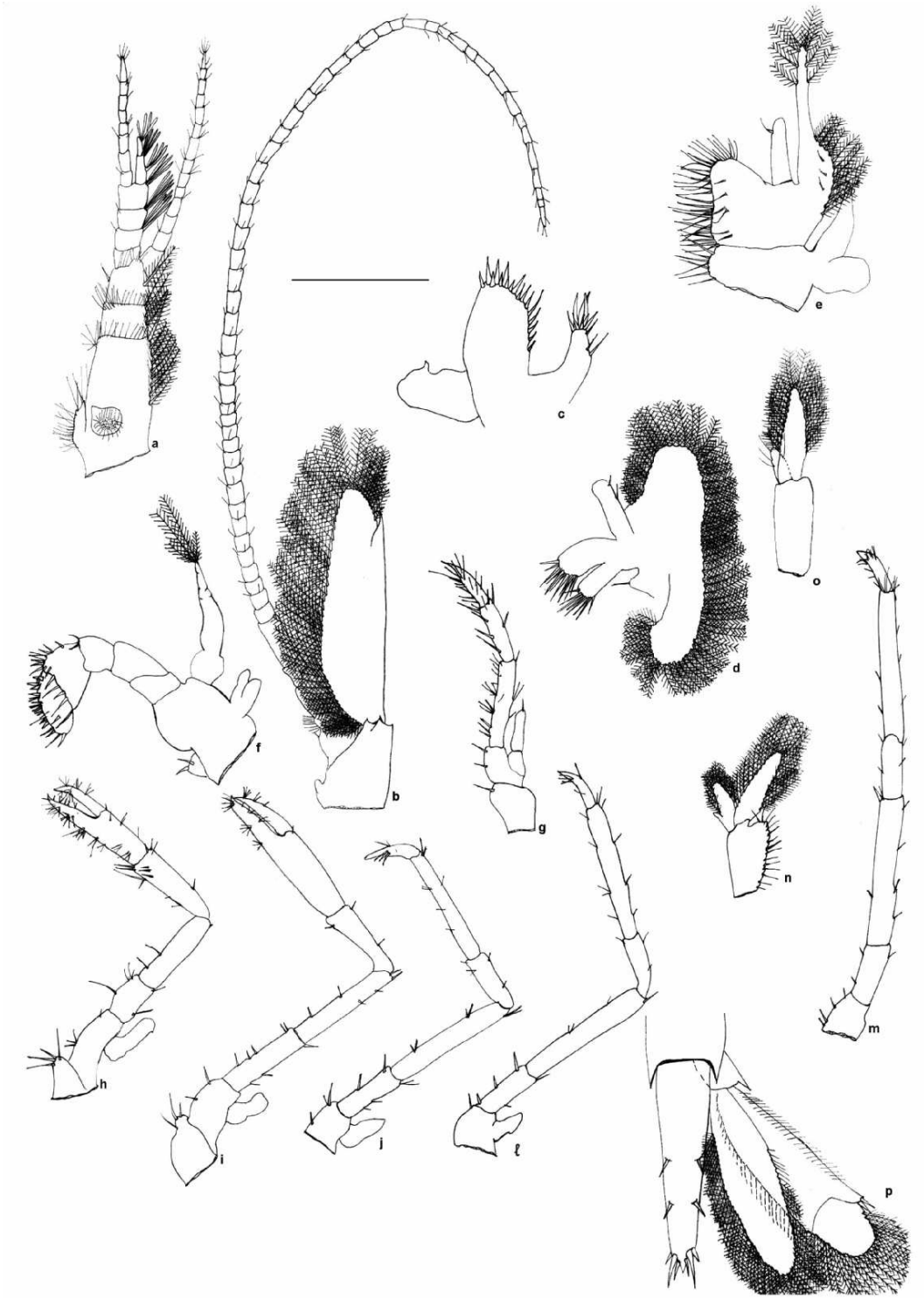

Figure 10 **-** *Palaemon paivai* Fausto-Filho, 1967. Juvenile I. (a) antennule; (b) antenna; (c) maxillule; (d) maxilla; (e) first maxilliped; (f) second maxilliped; (g) third maxilliped; (h-ℓ) pereiopods 1-4; (m) 5th pereiopod; (n-o) pleopods; (p) telson. Scale bar: a-c and g-p= 0.45 mm; e-f= 0.3mm.

DISCUSSION

According to the larval development type proposed by Sollaud (1923) for the Palaemonidae family, the larvae that inhabit Brazilian waters, *P. paivai* (present study) and two other species, *P. pandaliformis* and *P. northropi* were recorded as having a prolonged zoeal period: 8 stages for *P. paivai* and *P. pandaliformis* (GAMBA, 1998) and 8-9 for *P. northropi* (MOURA; ABRUNHOSA; PEREIRA DA COSTA, 1990; COELHO; SOARES; BARRETO, 1981). Therefore, they are included in the group "extended". This pattern is common among marine to brackish-water species (KNOWLTON; VARGO, 2004; MAGALHÃES; WALKER, 1986; WILLIAMSON, 1982). *Palaemon paivai* was recognized to be essentially a marine species (FAUSTO-FILHO, 1967), while *P. northropi* was found as in marine as well as brackish waters and *P. pandaliformis* in brackish and fresh waters (KNOWLTON; VARGO, 2004; GAMBA, 1998; RAMOS-PORTO; COELHO, 1980).

In the present study, morphological comparisons of *Palaemon* larvae were restricted to the two other species that are in Brazil: *P. northropi* and *P. pandaliformis*. Unfortunately, the larval development of *P. ritteri* has still not been studied.

A detailed comparison of structural differences among zoea I of the three *Palaemon* species has revealed close morphological features between *P. northropi* and *P. paivai* (Table 1). Although, there are many distinct differences when comparing these species with *P. pandaliformis*. The first remarkable difference is that first zoea of *P. pandaliformis* lacks a pair of spines on the 5th segment, but they are clearly observed in *P. paivai* and *P. northropi*. According to larval illustrations by Gamba (1998) such structures arise in *P. pandaliformis* only at the second stage. *Palaemon paivai* exhibits quite elongated and curved abdominal spine, surpassing the median portion of the 6th segment (Figure 9c), while for *P. pandaliformis* and for *P. northropi* such spines are very small. Observing some other *Palaemon* larvae (KNOWLTON; VARGO, 2004; SHY; SHANG; LAI, 2005) for *P. floridanus* and *P. serrifer*, respectively, such characteristics appear to be uncommon among *Palaemon* species.

Differences were especially observed in the setae number of the coxal and basal endites of the maxillule. *Palaemon northropi* and *P. paivai* are similar, whereas the species *P. pandaliformis* shows a reduced number of setae, mainly in the basal endite. The exopods setation of the first, second and third maxillipeds are the same for *P. northropi* and *P. paivai* (6 setae) but there are only 4 setae recorded for *P. pandaliformis*. Other morphological similarities between *P. northropi* and *P. paivai* are in the setal arrangements of the telson (7 + 7) while *P. pandaliformis* bears 2 small central (6 + 2 + 6).

Table 1- Comparisons of morphological characteristics of first zoeal stage in three species of Palaemon that occur in Brazil.

Appendages	Species		
	P. pandaliformis (GAMBA, 1998)	*P. northropi* (MOURA et al 1990)	*P. paivai* (present study)
Total length (mm)	2.75-3.08	2.2 -2.5	2.7-2.9
Antennule			
Exopod	2A+1PS+2S	4A+1PS	4A+1S
Antenna			
Endopod	1PS+1S	1PS+1SP	1PS+1SP
Exopod	9PS+2S	1+4+5PS	2+4 +5PS
Maxillule			
Coxal endite	4SP	(4-5) +1S	4+1S
Basal endite	2SP	5S	5S
Endopod	1SP	1S	1S
Maxilla			
Coxal endite	4S	3+1PS	3+1PS
Basal endite	2S+2PS	4+3PS	4+3PS
Endopod	1PS+2S	1+2PS	1+2PS
Scaphognathite	4+1PS	4+1PS	4+1PS
1st maxilliped			
Exopod	4PS	2+4PS	2+4PS
2nd maxilliped			
Exopod	4PS	4+4PS	4+4PS
3rd maxilliped			
Exopod	4PS	4PS+4PS	4PS+4PS
Pereiopods	1, 2 and 3 biramous and rudimentary	1 and 2 biramous and rudimentary	1 and 2 biramous and rudimentary
Spine on 5th segment	absent	present	present
Telson	6+2 + 6PS	7+7PS	7+7PS

Abbreviations: A = aesthetasc; S = simple setae; PS = plumose setae; SP = spines.

Similarities between *P. northropi* and *P. paivai* are also observed along their larval development (Table 2). Most appendages, like scaphognathite of the maxilla and exopods of antennule, antenna and maxillipeds show heavy setose for both species. On the other hand, on the last zoeal stage these appendages bear few setae in *P. pandaliformis* compared with those two species. These facts undoubtedly suggest a close morphological relationship between *P. northropi* and *P. paivai* indicating that further studies have to be carried out in order to determine phylogenic position between these species.

On the other hand, some developmental differences are observed among the three species. The development of the antennule for *P. paivai* is quite complex compared with *P. northropi* and *P. pandaliformis*. The outer flagellum is biramous in *P. paivai*, having an inner ramous with 6-7 segmentations. In *P. pandaliformis* this appendage is only 2-segmented and, as for *P. northropi* this structure is absent. In addition, the first appearance of pleopods (bud) for *P. paivai* is observed as soon as stage IV arises, but only in the VI and VII stages for *P. pandaliformis* and *P. northropi*, respectively.

Table 2- Comparisons of morphological characteristics of last zoeal stage among three species of Palaemon that occur in Brazil.

Appendages	Spicies		
	P. pandaliformis (Gamba, 1998)	*P. northropi* (Moura et al. 1990)	*P. paivai* (present study)
Total length (mm)	4.20 – 4.63	8.10- 8.40	6.75
Exopod	3A+3S	4S+(4+4+4+3)A	(3+3+3+4+4+4+3+5+3+1)A
Endopod	(21-22)PS+1SP	(42-44)PS	(44-51)PS+1SP
Coxal endite	Not described	8+1S	(8-10+1S)+1PS
Basal endite		11+3S	9-11S
Scaphognathite	11-12PS	35-38PS	69PS
Exopod	4PS	6PS	6PS
Exopod	4S	10PS	14PS
Exopod	4PS	12PS	16PS
Pereiopod	Chelate	Chelate	Chelate
Exopod	10PS+1SP	35PS	44-51PS
Endopod	12PS	34PS	41-55PS

Abbreviations: A = aesthetasc; S = simple setae; PS = plumose setae; SP = spines.

CONCLUSIONS

The present study has reported that the palaemonid *P. paivai* bear distinct and unique morphological characteristics whether compared with others species of the same group, such fact suggests further studies that involve phylogeny and genetic to better understand this group of crustacean.

REFERENCES

COELHO, P. A.; SOARES, C. M. A.; BARRETO, A. V. **Desenvolvimento larval de *Palaemon northropi* (Rankin, 1898) (Crustacea, Decapoda, Palaemonidae), sob condições de laboratório**. In: III ENCONTRO DE ZOOLOGIA DO NORDESTE, 1981, Recife. Anais do III Encontro de Zoologia do Nordeste, Recife: Sociedade Nordestina de Zoologia, p. 20-34, 1981.

FAUSTO-FILHO, J. *Palaemon (Palaemon) paivai*, nova espécie de crustáceo do Brasil (Decapoda, Palaemonidae). **Arq. Est. Biol. Mar. Univ. Fed. CE**. v. 7, n.1, p. 19-22, 1967.

GAMBA, A. L. The larval development of a freshwater prawn *Palaemon pandaliformis* (Stimpson, 1871), under laboratory conditions (Decapoda, Palaemonidae). **Crustaceana**, Leiden, v. 71, n. 1, p. 9-35, 1998.

KNOWLTON, R. E; VARGO, C. K. The larval morphology of *Palaemon floridanus* Chace, 1942 (Decapoda, Palaemonidae) compared with other species of *Palaemon* and *Palaemonetes*. **Crustaceana**, Leiden v. 77, n. 6, p. 683-715, 2004.

MAGALHÃES, C.; WALKER, I. Larval development and ecological distribution of central Amazonian palaemonid shrimps (Decapoda; Caridea). **Crustaceana,** Leiden, v. 55, n.3, p. 279-292**,** 1986.

MOURA, M. G.; ABRUNHOSA, F. A.; PEREIRA DA COSTA, F. A. O completo desenvolvimento larval do camarão *Palaemon (Palaeander) northropi* (Rankin) cultivado em laboratório. **Rev. Caatinga**, Mossoró, v.

7, p. 111-134, 1990.

RAMOS-PORTO, M.; COELHO, P. A. Malacostraca. Eucarida. Caridea (Alpheoidea excluded). In: YOUNG, P. S. (ed.) **Catalogue of Crustacea of Brazil**, Rio de Janeiro: Museu Nacional. p. 325-350, 1998.

SHY J. Y; CHANG, J. J.; LAI, H. T. Complete larval development of *Palaemon serrifer* (Stimpson, 1860) (Crustacea, Decapoda, Palaemonidae) reared in laboratory, **J. Fish. Soci. of Taiwan**, Taiwan, v. 32, p.79–86, 2005.

SOLLAUD, E., Le développement larvaire des Palaemoninae.1. Partie descriptive - la condensation progressive de l'ontogenése. **Bull. biol. France-Belgique**, Paris, v.57, n.4, p.509–603, 1923.

WILLIAMSON, D. I. Larval morphology and diversity. In: Academic Press (ed.), **The Biology of Crustacea**. New York, p. 43-110, 1982.